

we can interpret the groups of marks made on the wax cylinder of the phonograph. Each group corresponds to a "shock" from the cords, and the smaller curves making up the group are due to the movements of the air in the resonators. Prof. Scripture is not satisfied with the theory of Helmholtz that the resonators develop overtones in a harmonic series, nor with that of Hermann, who asserts that the resonance tones need not necessarily be harmonic. He states that he cannot interpret his tracings by the rigid application of either of these theories, and he lays stress on the fact that the walls of the resonating cavities above the cords are not rigid like the resonators of musical instruments, but are soft, as if the wall were fluid. Such a resonator, he says, will give its own tone in response to all tones. We confess that here we are not able fully to comprehend the author's meaning.

Prof. Scripture endeavours also to establish a close relationship between the form of the vibration of the cords and the action of the resonators. According to him, the form of the vibration of the cord may be altered by changes in the action of the muscular fibres that tighten the cord, so as to produce a tone of a given

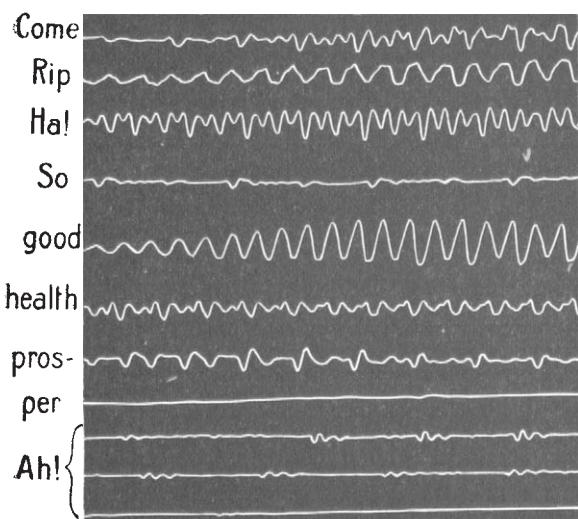


FIG. 1.—Curves of Rip van Winkle's Toast, spoken by the American actor, Joseph Jefferson.

pitch. Assuming that each muscle fibre has a separate nerve fibre (which is highly improbable), one can see that the tension of the cords, even when adapted to the production of a tone of a given pitch, might be so modified as to give out a tone-wave of a special form, and that thus an almost infinite variety of qualities of tone (tone-colours) might be produced. The special quality of tone would thus in the first instance depend on the psychical condition of the individual at the moment. In the next place, according to Prof. Scripture, the "water-wall" resonators, as he calls them, will develop their own tones, independently of the cord-tones, and thus, again, by a summation of these tones, the quality of the vowel-tone may be almost infinitely varied. In this way there is a physiological association between the movements of the cords and the action of the resonators.

Prof. Scripture also notes that each vowel has its own harmony, depending on the resonators, and that if it is sounded for even a short time its "melody" may change. This is why it is that when we examine the waves corresponding to a vowel as transcribed from the gramophone they are often seen to change in character as we approach the end of the series of

waves. The writer can corroborate this view from his observations by his own method of recording directly the vibrations of a phonograph recorder on a rapidly moving glass plate.

Prof. Scripture also points out a fact that was soon apparent to all observers in experimental phonetics, namely, that in the records of the phonograph or gramophone there are neither syllables nor intermediate glides, but a succession of waves, infinitely diverse in form, corresponding to the tones of the voice or the sounds of any musical instrument. The sound of a single vowel may be in a groove a metre long on the wax cylinder of the phonograph, and in the bottom of this groove there may be thousands of little groups of waves. The writer possesses records of songs that if drawn out would be 100 metres in length. Finally, Prof. Scripture lays emphasis on the effect of varying intensity as influencing quality. Apart from the theory of vowel-tones advanced by the author, this interesting lecture owes its value to the way in which Prof. Scripture approaches the problem from the physiological and psychological side. The mode of production of vowel-tones is in this sense not entirely a physical problem. We are dealing with living cords moved by living muscles, and with curiously shaped resonators having living walls.

JOHN G. MCKENDRICK.

GEOLOGY OF SPITI.¹

HERE are spots, insignificant in themselves, which have a world-wide celebrity among those interested in certain pursuits or investigations. Such is Ghel to the alienist, Shide to the seismologist, or Bayreuth to the musician, and such, too, is Spiti, a barren and sparsely inhabited valley in the centre of the Himalayas, which has long been known to geologists for its extensive series of richly fossiliferous rocks. A district like this could not long escape the notice of the Geological Survey of India, and one of the earliest volumes of its memoirs is that by Dr. F. Stoliczka and F. R. Mallet. Published in 1864, this remained the standard, and practically the only, description of the geology of Spiti until the publication, in 1891, of Mr. C. L. Griesbach's memoir, in which, while adopting his predecessors' mapping in the main, he introduced great modifications in the sequence. Neither of these descriptions, however, is entitled to rank as more than a reconnaissance, but now we have the results of what may fairly be described as a survey of this region, and, in an interesting and clearly expressed memoir, Mr. Hayden has gone far towards clearing up the points which were in dispute. In all cases where he has found himself at variance with his predecessors' conclusions he has produced good evidence, and it is in one way satisfactory that he is generally in agreement with the one who can no longer defend his views.

The Spiti valley contains representatives of every series from Cretaceous to Silurian, and a Cambrian age is inferred for a series of sedimentary, but unfossiliferous, beds underlying the latter. In all these Mr. Hayden not only collected from known, but also discovered several previously unknown, fossil-horizons, among the most interesting of which we may mention that of the land plants of Culm age. In the Silurian he has restored Stoliczka's correlation and fully supported it by fossil evidence; on the other hand he has confirmed Mr. Griesbach's discovery of Lower Triassic beds, and his conclusion that there is, in Spiti, a continuous conformable sequence from Permian to Upper Trias, and in this connection has rendered ample

¹ "The Geology of Spiti, with Parts of Bashahr and Rupshu." By H. H. Hayden. (*Memoirs of the Geological Survey of India*, vol. xxxvi, part i.) Pp. vi+129; illu. (Calcutta: Government Printing Office, 1904.)

acknowledgment of the work of the late Dr. A. v. Krafft, by whom it had been intended that the description of the Triassic rocks should be undertaken.

A chapter is devoted to the correlation of the unfossiliferous sequence of the outer Himalayas with that in Spiti, and an impartial account is given of the guesses—they are nothing more—which have been made. Mr. Hayden does not attempt to deliver judgment on this vexed question, but seems inclined towards Dr. Stoliczka's view; in this we think that he has not taken sufficient account of what may be called extra-Himalayan considerations. The differences between Spiti and the outer Himalayas, the long sequence of fossiliferous rocks in the one, the complete absence of fossils in the other, seem to admit of only two explanations—either the rocks of one area are unrepresented in the other, or the conditions of deposition were so dissimilar that lithological similarity in the two areas is not to be looked for, and either supposition precludes all hope of direct correlation.



FIG. 1.—Muth Quartzite at Head of Tei River, Bashahr. 6, *Diaonella* Shales; 5, Muschelkalk; 4, Lower Trias; 3, *Productus* shales; 2, Muth Quartzite; 1, Silurian limestone. From "The Geology of Spiti."

The memoir is indexed and illustrated by plates, several of which are reproductions of photographs by the author; it bears the stamp of careful work, and is worthy of the reputation of the Geological Survey of India. We regret that we cannot say as much for the method of stitching adopted by the Calcutta Government Press; the book may be re-bound, but the torn and mangled leaves can never make a seemly volume.

SIR LAUDER BRUNTON ON THE NEED OF PHYSICAL EDUCATION.

THE report of the inter-departmental committee on physical deterioration, while in the absence of scientifically ascertained data it hesitated to pronounce the evil it investigated to be widespread, has pointed us all to a better way, and Sir Lauder Brunton in these two addresses drives home the lesson.

¹ January 5.—National Federation of Head Teachers' Associations; "The Proposed National League for Physical Education and Improvement." January 6.—Incorporated Society of Medical Officers of Health, "The Report of the Inter-Departmental Committee on Physical Degeneration."

In speaking at Cambridge to the Head Teachers Association on the National League, which owes its inception to his statesmanlike grasp of the psychological moment at which to enlist the sympathy and interest of the nation, half alarmed, half repentant of its easy optimism and *laissez-faire*, Sir Lauder Brunton went direct to the point—

How can we alter most surely and speedily those conditions which tend to physical deterioration?

The answer lies in a nutshell. By training the young to open-air work and play, to care of teeth and exercise of muscles, the girls in preparation of appetising food, the boys in such drill as will make them real defenders of their country.

We may not go so far as Sir Lauder in his belief in the educative value of the wall picture of the ravages of the tubercle bacillus—we remember the fearful joy with which we contemplated a ghastly picture of volcanic colouring which an old lady assured us was an accurate delineation of a drunkard's stomach—not do we think his picture of the country cottage altogether accurate; but he has seized the fact that the master of the situation is the teacher, and to the teacher he turns, confident in his zeal, his devotion his stimulating propaganda, his patient training confident, too, in the plastic material our schools bring to his hand.

To another large class of workers in the public service, the medical officers of health, Sir Lauder Brunton also appeals. He pointed out to the Incorporated Society that physical efficiency is more than doubtful in the mass of people even if physical deterioration is unproved.

For accurate data as to height and weight, growth and physical development of the youth of the nation, we must look to the teachers in daily touch with them. Such data have hitherto been conspicuous by their absence, but once in existence they will enable the statesman and statistician alike to realise the problem they have to solve.

This involves periodical measurement, and to render their task effective the teachers will need instruction, and the most likely person to be called in to give that instruction is the M.O.H. Without trenching on the medical profession the teacher may learn from them to detect signs of fatigue or mental strain, to note defective vision and physical weakness, all of which too often escape notice until irremediable mischief is done.

Sir Lauder Brunton dwelt on the question of the milk supply, the feeding of underfed school children, and the housing question, and warmly endorsed the committee's recommendation that the medical officer of health should have security of tenure in view of the local jealousies he may arouse, the local prejudices he may cross. Discussing the report, Sir Lauder Brunton approved the desire for a Board of Health to undertake some of the duties of the over-worked Local Government Board; failing such a board, he cordially welcomed the idea of an advisory council for matters concerning the national physique, such council to consist of representatives of the Departments of State reinforced by men of science and by experts in questions of health and of physical development.

He is assured of the readiness of the medical profession to do their part in the educative work; he believes in equal readiness of the teachers to learn and teach what it is of vital importance the coming generation should acquire, not only theoretically, but practically—a knowledge of the laws of health.

The National League for Physical Education and Improvement has so far been mainly confined to the medical profession, but now that its aims are focused and defined Sir Lauder looks to a wider public. He